Supporting Information

Structural Color Circulation in a Bilayer Photonic Crystal by Increasing the Incident Angle

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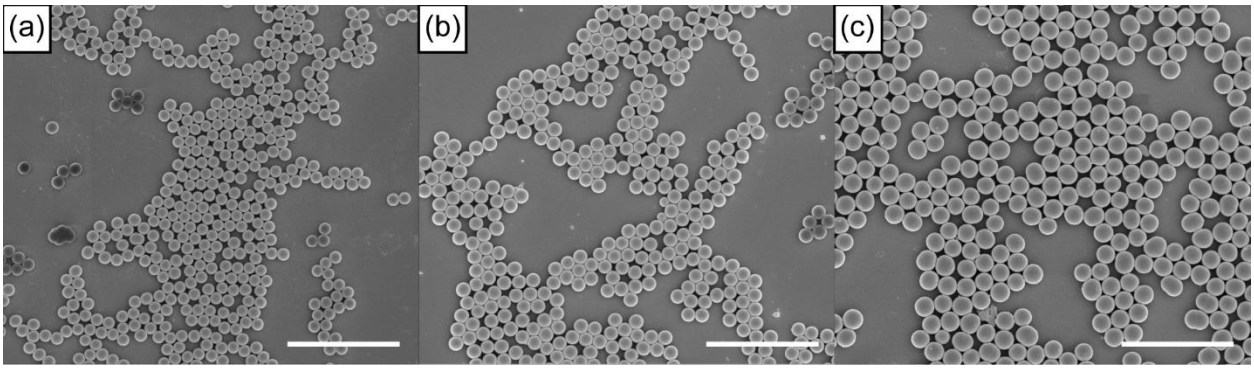

Figure S1. The SEM images of SiO_2 microspheres of 210 nm, 250 nm and 330 nm, respectively. (a) 210 nm, (b) 250nm, (c) 330 nm. (Scale bar: 2 μm).

According to Bragg's law and Snell's law, the photonic stop bands of FCC structured PCs can be theoretically calculated as

$$\lambda = 2\sqrt{2/3}(D)\left(\sqrt{n^2 - \sin^2\theta}\right) \qquad (1)$$

$$n^2 = 0.74 \times {n_0}^2 + 0.26 \times {n_c}^2 \qquad (2)$$

Where λ is the wavelength of reflection peak; θ *i*s the incident angle, equal to the detection angle; D is the diameter of the latex particles; n is the effective refractive index; n_0= 1.45 and n_c = 1.0 are the refractive index of silica and the air, respectively.

We can prepare some value of silica nanoparticles we need through the Bragg's law of diffraction. So we can convert the formula into another form like

$$D = \lambda / \left[1.63 \times \sqrt{(1.82 - \sin^2\theta)}\right] \qquad (3)$$

Taking an example, if the bandgap of the PC is in NIR region when θ locates in little angle, we can set λ as 700 nm and θ as 5° to calculate the diameter of the silica we wanting.

Table S1. Diameter of the silica microsphere we used

λ (nm)	θ (°)	Theoretical D (nm)	Practical D (nm)
700	5	328	~330
530	5	248	~250
450	5	211	~210

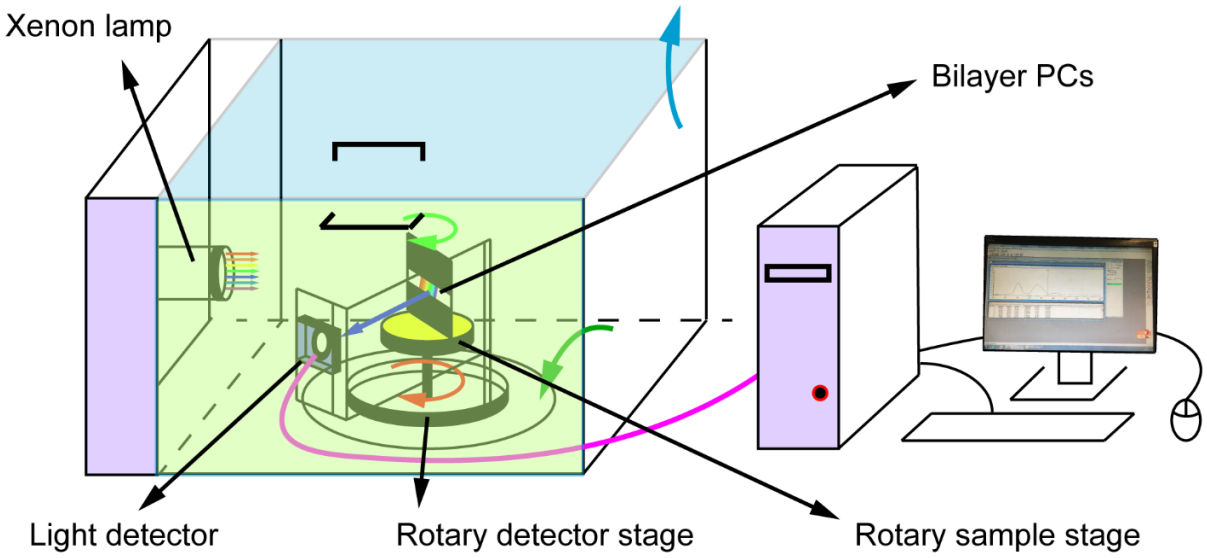

Figure S2. The schematic diagram of the measurement setup.

The schematic diagram of the measurement setup (Hitachi U-4100 spectrophotometer) is shown in Figure S2. The Xenon lamp here serves as the simulative light source for the reflection and transmission testing. In order to test the reflection spectra, the sample stage and the detector stage must be angle-changeable, so both of the stages can be rotated. The test condition is a closed dark environment.

Taking θ=5° as an example, firstly, rotate the sample stage to 5 degrees, then rotate the detector stage to 10° to ensure that the incident angle is equal to the reflective angle. The box is closed during the test.

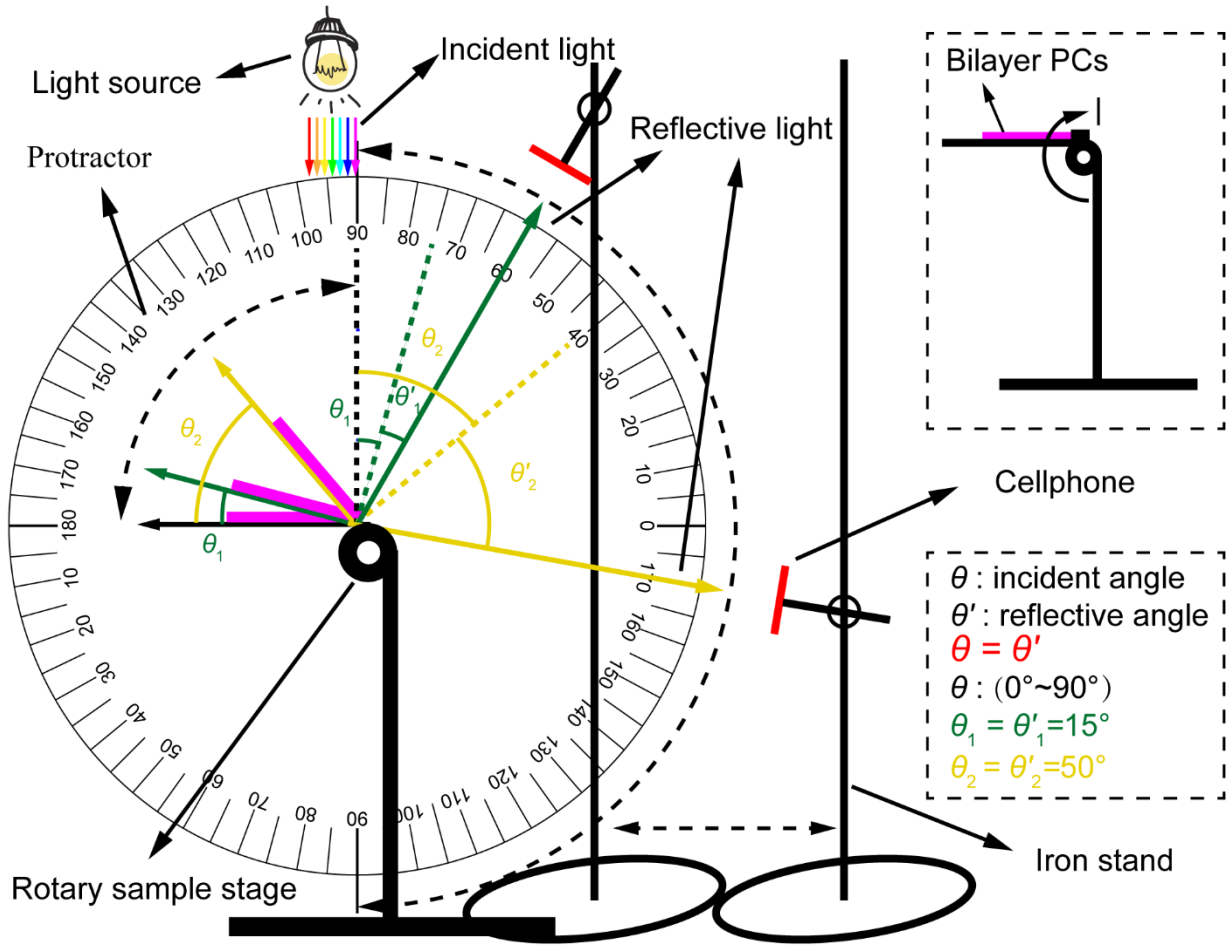

Figure S3. The schematic diagram of the taking photos method.

For the method of taking photos, there is a light source, a protractor, a rotary sample stage, a cellphone and an iron stand to secure the cellphone. The specific combination is shown in Figure S3. The detailed operation steps are as follows:

The first thing needs to be determined is that the light source is fixed to perpendicular to the sample stage. But the sample stage can be rotated to change the angle of the incident light during the process. We can use the protractor to make sure how many degrees the sample stage is rotated, and then determine the position of the receiver (cellphone) to ensure that the photos taken is the specular reflection.

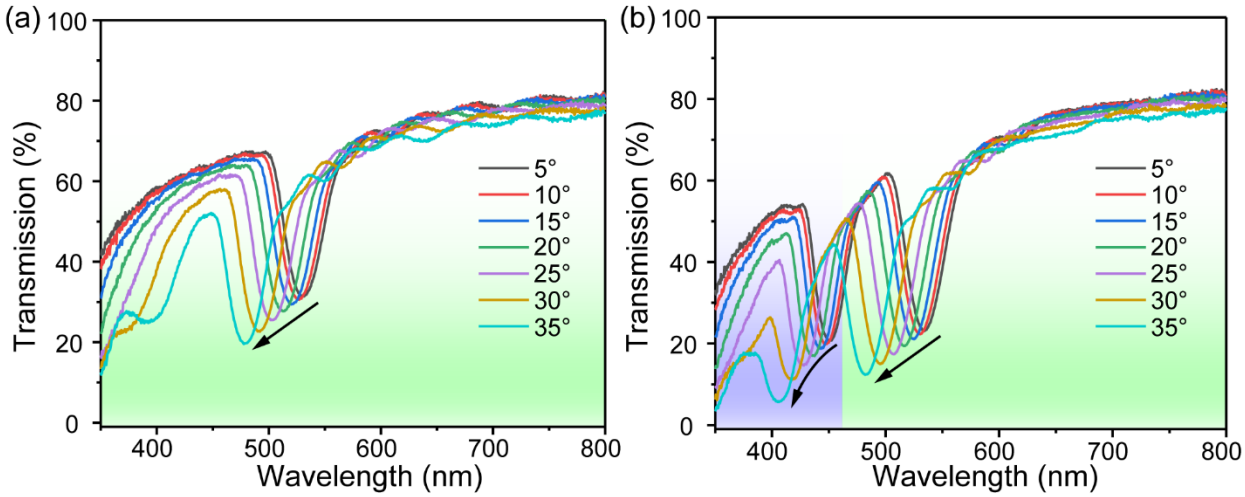

Figure S4. (a) Transmission spectra of single-layer PCs assembled from 250 nm SiO_2 microspheres at different incident angles. (b) Transmission spectra of bilayer PCs (210 nm plus 250 nm) under different incident angles.

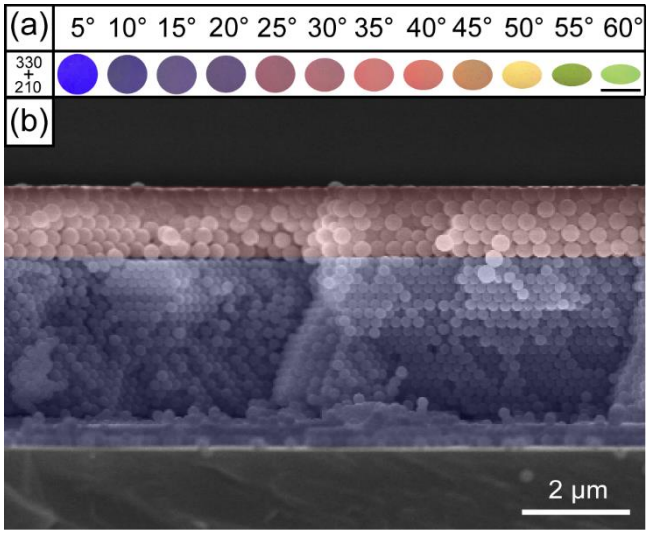

Figure S5. (a) Digital photos of the bilayers PCs assembled from 210 nm and 330 nm SiO_2 nanoparticles at different incident angles. (b) Typical cross-sectional SEM image showing the bilayers PCs assembled from 210nm and 330 nm SiO_2 microspheres. (Scale bar (a): 1 cm)

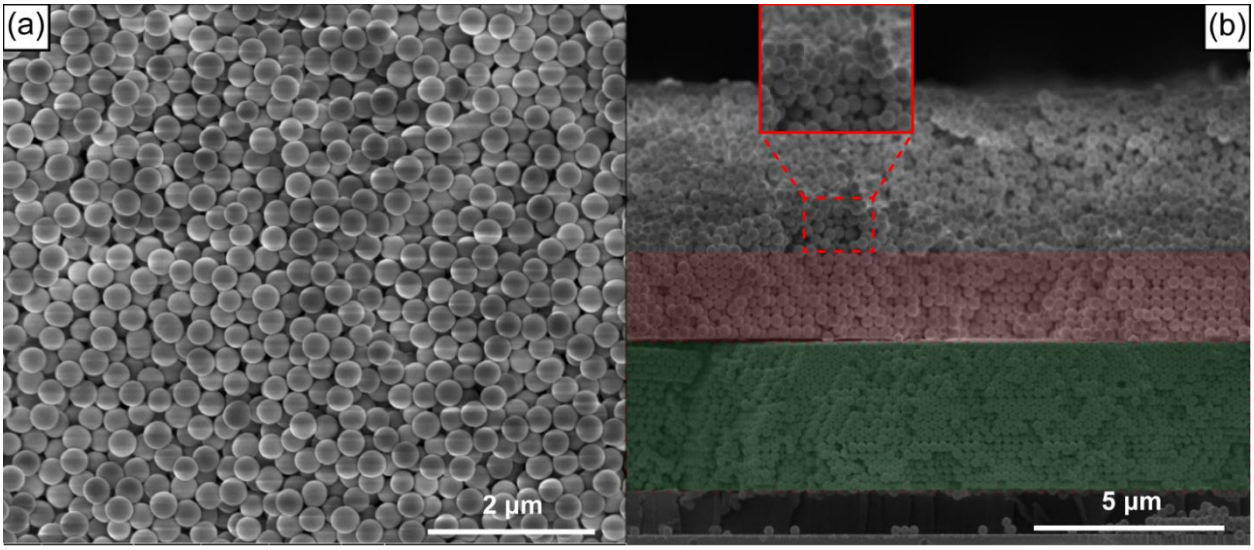

Figure S6. (a) The surface SEM image of the sprayed region. (b) The cross-sectional SEM image of the sprayed region.